DOCUMENT RESUME

ED 126 920 IR 003 835

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TITLE Techniques and Technology: Affecting Variables That Make a Difference.
PUB DATE 21 Jul 76
NOTE 14p.; Paper presented at the International Learning Technology Congress and Exposition on Applied Learning Technology for Human Resource Development (Washington, D.C., July 21-23, 1976)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Affective Objectives; *Educational Technology; Instructional Media; Learning Theories; *Predictor Variables; Success Factors

ABSTRACT

Educational technology involves the application of psychology and equipment to the solution of educational problems. Teaching is facilitated when the interrelationships of variables such as time allowed for learning perseverence, quality of instructional materials, affective behavior and goals, and aptitude are considered. In order for educational technology to have a maximum impact, attention should be directed to the manipulation of as many of these variables as possible. The educational technologist should seek to uncover new functional relationships that will lead to advances in understanding the instructional process. (CH)

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ED126920

Techniques and Technology

"Affecting Variables That Make A Difference"

by

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Paper presented at the Second Symposium on Applied Learning Systems: Professional Development Program, Washington, D.C., July 21, 1976.

IR 003 833

Persons interested in learning systems want to affect those variables in the learning environment that make a difference in the learner's final performance. It will do no good to lament the poor preparation of our learners, or to blame their learning problems on genetic inheritance. It is the job of the educator or technologist to take those whom he is given and to change their behavior in some specified way. The question is, how? What can be done? What variables are there within the present learning environment that can be manipulated, and how do they make a difference?

One way of approaching the problem is to investigate a conceptual model of learning such as John Carroll's (1963) model of school learning, and to see how instructional techniques and technology affect the manipulations of variables hypothesized to make a difference. Carroll's model is chosen here because it has generated a fair amount of research and is generally supported by the research findings (Lewis, 1969, Bloom, 1973, Carroll, 1973). Carroll's model states that the degree of learning that an individual attains is a function of the time he spends in learning over the time he actually needs, i.e.:

$$\text{THE DEGREE OF LEARNING} \quad f\left(\frac{\text{time actually spent}}{\text{time actually needed}}\right)$$

Carroll and others (Block, 1971) break the factors of time spent and time needed into a number of component variables as represented

below:

$$\text{TIME ACTUALLY SPENT} \; f\left(\text{Time Allowed} \cdot \text{Perseverance}\right)$$

$$\text{TIME ACTUALLY NEEDED} \; f\left(\text{Aptitude} \quad \text{Ability to Understand} \cdot \text{Quality of Instruction}\right)$$

By affecting any of the five variables identified, the time needed can be reduced or the time spent can be increased, thus affecting the degree of learning that takes place. The purpose of this paper is to explore how techniques and technology might affect these variables.

Time Allowed

Bugelski (1971) states in his theory of teaching, that all learning takes time. This time is the period during which some activity related to the material to be learned is taking place (p. 282). Due to background differences among learners, we can expect that different amounts of time with the materials will be needed. A corollary of Bugelski's time principle is that only so much can be learned in a given time. The implication is that restrictions on time allowed will negatively affect the total degree of learning that can take place.

Time, obviously,is a variable that can be affected by applications of technology. Individualized or self-paced materials depend upon learner control of the stimulus materials. The conventional classroom, or teacher-paced instruction has some advantages, but its biggest disadvantage is that it is ephemeral. When the presentation is finished, it is gone except for what has been

committed to memory, or written as class notes. The presentation, by its very nature, restricts the time the learner has in contact with the stimulus materials that are supposed to change his behavior. By mediating the same lecture (in print, audio-tape or videotape) a representation of the stimulus can be made available for greater periods of time if the learner needs it. However, time is probably the most obvious variable and it has been getting its share of publicity through writers on mastery learning such as Block (1971), and Bloom (1973). There are other variables that affect the learning equation, and perhaps it is more efficient in the long run to manipulate these other variables.

Perseverance

All the time in the world is not going to cause a person to learn anything if he doesn't spend time in contact with the stimulus materials. A primary tenet of behavioral technology, as practiced in education, is that students must actively engage the stimulus materials in order to learn from them (and conversely, the more time they spend the more they learn). Perseverance may be thought of as the time the student spends actively in contact with the stimulus materials. Studying is a behavior in the student's repertoire that has a lot of competition from other behaviors (recreation, work, sleeping). The behavioral technologists believe that in order to attain the amount of study behavior that is desirable, studying must be made to pay off with rewards that can compete with other rewards gained from competing behaviors. Consequently, behavioristically oriented learning systems use grades or other incentives to reward achievement. Achievement is a function of time

spent at learning, and so we can say that the behaviorist affects a student's perseverance. The rationale behind the behaviorist's system is simple--provide for multiple short-term payoffs. Student study-behavior increases drastically before exams, as most teachers know, yet these teachers seem to ignore this observation when trying to affect learning.

Applications of Behavioral Technology are exemplified by Keller's (1968) P.S.I. system and Postlethwaite's (1969) Audio-tutorial System. Both systems include frequent exams over relatively small segments of instruction. The instructional technologist can affect the student's perseverance by carefully planning the management of instruction, paying attention to the payoffs for the learner.

Another function of technology hypothesized to affect the perseverance of the learner is its novelty or attention arousing capablilities. Berlyne, (1965) postulates that novel presentations raise the level of epistemological (thinking) activity on the part of the observer. In other ways, techniques and technology can actively involve the learner in the instructional process by calling for responses, or by having the learner perform certain operations in order that the stimulus presentation continue. The attention commanding aspects of certain techniques should not be taken lightly when listing the advantages of technology in learning systems.

Perseverance may also be a factor affected by the student's attitude toward various technology and techniques used in instruction. If there is a negative attitude toward programmed instruction in general (regardless of how it originated) the learner is less likely to approach and utilize this learning resource. In a somewhat different way, an attitude toward the use of a particular

medium, such as commercial television, may also affect what a listener perceives as the message. This might be illustrated by hypothesizing that a prospective learner convinced that commercial television was politically controlled by the interests of large corporations might not give any credibility to a program on tax reform. "Attitude", with regard to the credibility of sources has been studied extensively (Hovland, 1953)however, how attitudes towards different technologies or techniques affect the amount of time spent on learning from the same, has not, to this writer's knowledge, been explored.

Quality of the Instructional Materials

Almost any educator or trainer would agree to the statement that individuals learn better when they have "good" materials. But what are the attributes of "good materials"? At a seminar at Florida State University, Dr. Jack Michaels, a behavioral technologist from Western Michigan University, listed what he believes to be three important factors of good materials. They are, 1) sequence, 2) completeness, and 3) lack of irrelevant information. For many reasons these three factors have been studied throughout the history of educational psychology in the context of many different theories. For the purpose of this paper, the degree of importance of each of the three will not be argued, but rather, the issue to be explored is what techniques and technology might affect these variables. At this point it becomes obvious that instructional technology is more than just hardware. The process of instructional design or the application of instructional design models are directed at producing

what we would call quality materials. This consists of materials that are well organized (sequence), that contain all the necessary prerequisites (complete) and are directed toward the attainment of prespecified objectives (lack irrelevant materials). The basic components of the design process; needs analysis, task analysis, materials production, and evaluation are applied in an iterative manner to ensure their effectiveness given the proper amount of time, and perseverance on the part of the learner. The design aspect of technology is currently being stressed in schools of education and its application is being made at all levels of schooling, in industry, and in the military. Its promise lies in the fact that it is learner-oriented rather than teacher-oriented.

Instructional systems design allows for consideration of alternative delivery systems depending on the nature of the outcomes desired. Although its purpose is not to do away with the traditional classroom, it is through the application of instructional systems design that one begins to realize how inefficient the classroom mode of instruction is for certain types of learning tasks. It also provides a rationale for providing classroom instruction to obtain certain outcomes that cannot be provided effectively or efficiently by mediated means, e.g., when a role model is appropriate.

Instructional systems design opens a new approach for applied psychology in learning. Using a systems' design model, a researcher can begin to test theories regarding transfer, relationships among types of learning, and appropriate methods for affecting multiple outcomes from different domains of learning as described by Bloom (1956), and Gagne (1974). Design procedures, focused on producing "quality instructional materials," enable those that care to improve instruction to affect one more variable that can "make a difference" in learning.

Ability to Understand

Carroll (1963) considered the ability to understand as a function of an individual's general intelligence. Although an educator cannot manipulate an individual's intelligence, he can take it into consideration when designing instructional materials. With regard to theory related to the selection of appropriate techniques and technology (media selection) based on an individual's ability to understand, there is definitely a knowledge gap. One problem in defining a theory of media selection is the multivariate nature of the message-medium-learner interaction. One theory with regard to cognitive learning and media selection derived from Dale's (1969) "Cone of Educational Experience," is provided by Leslie Briggs (1972) in his A.I.R. monograph on instructional design. This

model was expanded by Wager (1975) to include the affective or attitudinal domains. Conceptually based models such as these are valuable for further theorizing and research concerning the manipulation of the media variables with regard to observable learner characteristics.

Understanding the effects of techniques and technology on various types of learners is important to our understanding of our efforts at manipulating some of the variables mentioned previously. For example, instruction that is beyond the learner's capability to understand is not going to be any more effective if more time is alloted, or if a more powerful incentive system is provided. A person who cannot read will simply not be able to benefit from textual instructional materials until he gains the learning skill of reading. This example, of course, is too obvious. What is not clear is how techniques and technology might affect the more subtle differences among learners.

At this point the writer wishes to express the concern that instructional technologies are spending a considerable amount of time and energy defining cognitive goals and objectives for instructional programs, and developing instructional materials to obtain these goals, without specifying the attitudinal goals, and measuring whether or not they are attained. The writer does not mean to infer that designers or educators do not recognize the importance of affective outcomes; simply that they are often overlooked in the task analysis process. There may be many reasons for this,

but the effects of this oversight could lead to a misunderstanding of which technique or technology is best suited to a particular instructional program. It is probably more with regard to attitudinal goals than cognitive goals that justification for elaborate and expensive techniques such as simulation, or on-the-job training can be made. An individual's ability to understand is a complex variable affected by perceptual as well as intellectual processes. An understanding of how techniques and technology relate to these processes will affect the educator's ability to manipulate the necessary factors in a facilitative way.

Aptitude

We know that some individuals are more disposed toward learning math than others, and that while they may find math easy they struggle to learn English grammar. This ability to learn a particular thing is generally refered to as "aptitude." This writer suggests that an individual is not born with an aptitude toward any particular subject or skill but develops it as a result of his history of learning experiences. An individual frequently displays the "aptitude" toward those things his parents do or those activities they support as "importnat." At a particular grade level the person that has been exposed to more math will (all other factors being equal) probably show more aptitude toward math. However, all things are seldom equal, and there are probably

other factors that affect the individual's aptitude toward math, such as the cognitive strategies that the learner can relate to the task at hand. A cognitive strategy might be thought of as a scheme for learning that the learner possesses (and probably learned) and calls into use for the new learning task. How can techniques and technology affect this dimension of the learning equation?

Perhaps this is where critics of technological applications are somewhat correct. We teach our students how to do things without teaching them to learn (remember the frequently cited goal of education is to teach people how to learn). If this is true, it is probably due to our lack of knowledge about those strategies that might be taught as a formal part of the instructional program. This writer would submit that the persons making these statements would know as little about teaching them as the technologist. A recognition of the need to explore and research this variable might have a large payoff for those concerned with improving instruction, as it is currently the one known least about.

Summary

Educational technology includes the application of psychology and hardware to the solution of educational problems. This effort is facilitated by the realization that learning is affected by many complex and interrelated variables, and that in order to have maximum impact

attention should be directed to manipulating as many of these variables as possible. At the same time the technologist realizes the limitations of his knowledge and available theories with regard to instructional design, and he is constantly formulating new hypotheses and uncovering new functional relationships that lead to advances in understanding the instructional process. This writer maintains that it is this element of exploration and inquiry that makes the field of instructional technology so exciting, especially when one affects a variable that "makes a difference."

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